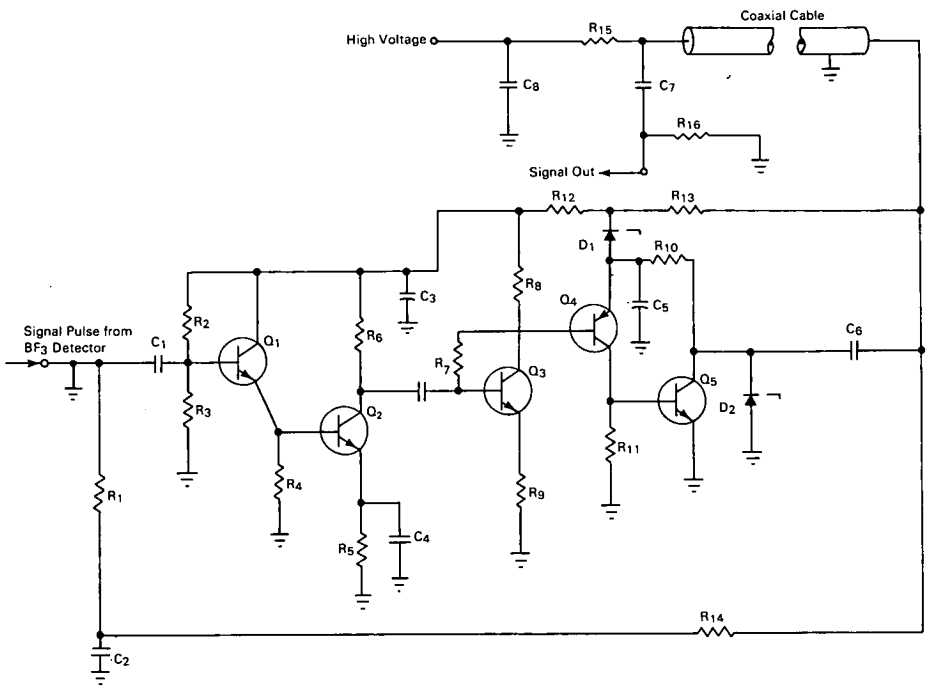
NASA TECH BRIEF

BF_3 Nuclear Detector Preamplifier Uses Single-Cable Connection



The problem: In a nuclear particle detector (such as a boron trifluoride neutron detector), it is often advantageous to use a preamplifier in conjunction with the detector tube to improve the signal-to-noise characteristics of the system. The system normally requires three interconnecting cables: one to supply the high voltage to the detector tube; one to supply the preamplifier operating voltage; and one to carry the signal pulse back to the counter. Since long stretches of cable are expensive and troublesome to maintain, a system using one interconnecting cable is desirable. However, a single-cable system must be capable of isolating the preamplifier from the high-voltage supply (which would destroy the elements of the preamplifier).

The solution: A preamplifier with isolating and bypass networks permits operation with a single interconnecting cable.

How it's done: The signal pulse from the BF_3 detector is coupled through capacitor C_1 to transistor Q_1 in the preamplifier circuit (transistors Q_1 through Q_5). The detector load resistor R_1, capacitor C_2, and resistor R_{14} isolate the detector from the high-voltage (1000 to 2500 volts dc) supply, which maintains the preamplifier at an operating level of approximately 15 volts. All ac pulses are removed from the transistor

(continued overleaf)

supply voltage by capacitors C_3 and C_5 and resistor R_{12}, thus preventing oscillation. Transistor Q_1 is an emitter-follower driving transistor Q_2, which is a conventional amplifier. Transistors Q_3, Q_4, and Q_5 are dc-coupled amplifier stages. The dc operating voltages and bias are clamped by Zener diode D_1 to maintain a very low standby operating current for the preamplifier and yet allow it to deliver the required peak current to the coaxial cable. The high gain and low output impedance of the preamplifier enable it to drive a 75-ohm, 1000-foot cable. The preamplifier output pulses are coupled to the cable by means of capacitor C_6. This capacitor initially charges through Zener diode D_2 to protect Q_5 against current surges. The signal is recovered at the end of the cable by a suitable resistor-capacitor decoupling network (R_{15}, R_{16}, C_7, C_8). The value of R_{15} must be equal to the characteristic impedance of the coaxial cable.

Notes:

1. The preamplifier, used to amplify the signal pulse from a BF_3 neutron detector in order to drive a low-impedance coaxial cable, is characterized by a high output pulse amplitude, good signal-to-noise ratio, and good discrimination against gamma pulses. It is capable of operating at temperatures to 100°C in moderately high gamma-radiation fields.
2. For best operation, the preamplifier should be installed within 1 to 3 inches of the BF_3 detector.
3. Inquiries concerning this innovation may be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio, 44135
   Reference: B65-10255

Patent status: NASA encourages commercial use of this innovation. No patent action is contemplated.

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